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Clinical characteristics and determinants of invasive mechanical ventilation outcome in adult intensive care unit in Northern Ethiopia: A resource-limited setting

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ABSTRACT

Objectives: Mechanical ventilation (MV) is a primary modality of supporting organ function in patients who are treated in intensive care units (ICUs). Although it is lifesaving, it is also associated with life-threatening complications. This study aims to address the existing paucity of evidence on clinical characteristics and determinants of invasive MV outcomes in adult ICU in North Ethiopia.

Materials and Methods: The study was conducted in the adult ICU of Ayder Comprehensive Specialized Hospital. A hospital-based prospective study was conducted to collect data using the purposive sampling technique to include all the patients who received invasive MV from January 2017 to October 2017. Data were analyzed using SPSS version 23.

Results: MV was utilized in 36.7% (n = 105) of critically ill patients admitted to the ICU. The two most common indications for invasive MV use were hypoxic respiratory failure 44.8% (n = 47) and coma 35.2% (n = 37). The mortality rate among patients who received invasive MV was 28.6%. Age above 60 years and development of septic shock after intubation were significant determinants of invasive MV-related mortality.

Conclusion: A significant number of patients admitted to the ICU require respiratory support with invasive MV. Old age and the development of septic shock after intubation were significant determinants of mortality for patients under invasive MV.

Keywords: Mechanical ventilation, Intensive care unit, Limited resource setting, Outcome

INTRODUCTION

Widely available and advanced in developed countries, critical care in resource-limited settings remains scarce and substandard.[1] As a result, treating critically ill patients in such a setting is challenging resulting in a high rate of mortality from treatable diseases.[2] Critical care faces the same challenges as other aspects of health care in the developing world. However, the provision of critical care services in developing countries is met with additional challenges. It is either inaccessible or complicated to provide due to a lack of technology and other resources, lack of context-specific evidence for decision-making, high cost associated with running intensive care unit (ICU), and institutional barriers to the implementation of lifesaving interventions.[2,3] In the

developing world, patients requiring ICU care are generally younger and with less comorbidity, giving a remarkable opportunity to salvage more lives, arguably much more so than in the Western world.[3]

Mechanical ventilation (MV) is an integral part of critical care.[4] Among the millions of patients admitted to ICU globally, approximately one-third receive MV.[5] It is the most frequent reason patients are admitted and is one of the most commonly employed interventions in the ICU.[5,6] MV reduces the work of breathing and improves gas exchange in critically ill patients with acute hypoxemic respiratory failure and ventilatory failure. About 40% and 53% of patients admitted to ICU in Egypt and Ethiopia, respectively, receive MV;[7,8] rates reflective of ICU patient admissions at a later stage of their disease requiring higher rates of MV usage in resource-limited settings.

However, countless preventable deaths occur in low-income countries primarily due to a lack of functioning ventilators.[9] The provision of MV is continually saving lives in developed countries; however, deaths continue to occur in developing countries due to a combination of factors that hamper access to MV or pose impediments to the quality of critical care.[1]

Only a few ICUs are available in resource-poor settings.[10] ICUs in Ethiopia are constrained by considerable deficiencies in emergency drugs and essential equipment.[11] In 2020, more than 10 countries in Africa had no mechanical ventilators.[12] In recent years, the Ethiopian government has endeavored to open additional ICUs but mechanical ventilators remain limited in number.[13] The lack of ICU beds and mechanical ventilators is prevalent in our setting.[14]

MV in the ICU is associated with significant adverse effects and complications, some related to the critical care of the mechanically ventilated patient including, pain, discomfort, delirium, sleep disruption, immobility, infections (ventilator-associated pneumonia [VAP]) and ICU-acquired weakness, and others attributable to the ventilator itself.[5,15] A constellation of adverse effects and complications may be associated with MV use, although, in many instances, the causal role of the ventilator itself has not been established.[16]

Despite the availability of limited MV services in health-care facilities in Ethiopia, only a few studies have explored patient outcomes with the use of this intervention. Moreover, only a few studies are available on the use of MV in an African setting. This study aims to assess clinical characteristics and determinants of invasive MV outcomes in adult ICUs in North Ethiopia.

MATERIALS AND METHODS

Study area and period

The study was conducted under a Ayder Comprehensive Specialized Hospital (ACSH). It is a tertiary care hospital serving a catchment area of close to 9 million people from Tigray and neighboring districts of Amhara and Afar regions. Its adult ICU was established in 2010 with eight beds, four mechanical ventilators, two cardioverter/defibrillator devices, one bedside ultrasound machine, and a portable X-ray. However, there is no functional arterial blood gas analyzer in this ICU. It receives referrals from all health facilities in Tigray, and all service areas in the hospital, including surgical and neurosurgical adult patients. Due to a lack of critical care specialists, this ICU is run by internists with short basic training in critical care. In collaboration with the US- and EU-based partner university hospitals, ACSH had been organizing proctored onsite hand on pieces training for internists, surgeons, and pediatricians. Both basic and advanced life support training was being offered to nurses, general practitioners, residents, and senior staff involved in attending ICUs and handling patients under MV. The duration of the training ranged from 6 weeks to 3 months. The ICU is staffed with one nurse per patient and a doctor is present 24 h/day. This study was conducted between January 2017 and October 2017.

Study design

A hospital-based prospective study design was implemented.

Study population

All patients who received invasive MV during the study period were included in the study.

Inclusion criteria

Patients who required initiation of invasive MV for more than 12 h were included in this study.

Sample size and sampling methods

A total purposive sampling was employed to include all patients who were admitted to the adult ICU and who were initiated on invasive MV. Patients were followed daily throughout their duration of MV and throughout their ICU stay.

Data collection tool and procedure

A structured data collection tool designed to meet the study objectives was developed from the literature review. This instrument had four parts: The sociodemographic characteristic, clinical characteristics of the patients, laboratory investigation, and factors related to the delivery of MV to the patient [Annex 1]. Data collection was carried out by physicians outside the ICU team and they were given important demonstrations to collect the data appropriately.

Informed written consent was obtained from the next of kin of patients who were eligible for the study. Sources of data were direct observation, chart review, and interviewing the next of kin of the patients based on the structured questionnaire.

Operational definitions

The outcome of the patient under invasive MV was assessed based on MV- and process of care-related outcomes.

MV-related outcomes

It assesses the use of MV, duration of MV, and complications that occurred including barotraumas, endotracheal tube blockage, unplanned extubation, and prolonged MV which is defined as ventilation required for >21 days.

Barotrauma

Barotrauma is defined as radiographically confirmed pneumothorax, pneumomediastinum, or subcutaneous emphysema that could not be attributed to iatrogenic injury.

Unplanned extubation

Any self-extubation by the patient or accidental extubation during position change or patient movement, or extubation for a blocked tube.

Process of care-related outcomes

It assesses development of venous thromboembolism (VTE), pressure sores, nosocomial infections, and adherence to the standard of care practices (VTE prophylaxis, gastric stress ulcer prophylaxis, sedation, and analgesia use).

Upper gastrointestinal bleeding

If patients have developed any stress-related new coffee ground/dark colored or bloody vomitus or evidenced on the nasogastric tube after MV, they are considered as having UGIB.

Septic shock

If patients with clinical evidence of sepsis have persisting hypotension requiring vasopressors to maintain mean arterial pressure of 65 mm Hg despite adequate volume resuscitation, they are considered as having septic shock.

Data management and analysis

Data were checked for completeness and were entered into an SPSS version 23. Proportion, percentage, ratios, and frequency distribution were used for descriptive analysis. The results were also presented using tables and graphs. Bivariate and multivariable regression analyses were also used to examine the association between dependent and independent variables. All independent variables were computed using bivariate logistic regression. Those which had $P < 0.2$ were fitted into multivariable logistic regression. This was executed using an odds ratio. The significance of statistical association was tested using a 95% confidence interval and $P < 0.05$.

RESULTS

Sociodemographic characteristics

Throughout the study period, 286 patients were admitted to the adult ICU. Majority (n = 105, 62.9%) of the study participants were male. The mean age was 38 years (SD: 16.8 years). Most patients were below 60 years of age. Nearly half of the study participants had no formal education [Table 1].

Clinical characteristics of the patients under invasive MV

Of the 286 admitted patients, more than one-third of them, that is, 105 (36.7%) received invasive MV. Both orotracheal and tracheostomy were the mode of invasive MV employed for the recruited patients. Among the patients included in the study, 37 (35.2%) patients had comorbidities. One-third (34.3%) of the study patients had a previous history of admission to a hospital within the previous 3 months of the current presentation [Table 2].

Table 1: Sociodemographic characteristics of patients using invasive mechanical ventilation in ACSH adult ICU, January–October 2017.

Variable	Frequency	Percent
Age in years (Mean+SD)	38+16.8	
Age		
60+years	17	16.2
<60 years	88	83.8
Sex		
Male	66	62.9
Female	36	37.1
Level of education		
Higher education	14	13.1
Secondary education	22	21.0
Primary education	20	19.0
No formal education	49	46.9
Residence		
Urban	59	56.2
Rural	46	43.8

ACSH: Ayder Comprehensive Specialized Hospital, ICU: Intensive care unit

Table 2: Clinical characteristics of the patients under invasive mechanical ventilation in ACSH adult ICU, January–October 2017.

Variable	Frequency	Percent	95% confidence interval	
			Lower	Upper
Admission disease category				
Medical	63	60	52.4	69.5
Neurosurgical	30	28.6	20.7	37.4
General surgical	9	8.6	3.8	12.4
Obstetric related	3	2.9	0	6
Comorbidity				
Yes	37	35.2	7.2	61.3
No	68	64.8	55.9	73.3
Type of comorbidity				
Hypertension	7	6.7	1.9	11.7
HIV infection	6	5.7	1.9	11.4
Post-surgery	5	4.8	1	9.5
Bronchial asthma	4	3.8	1	9.8
Epilepsy	4	3.8	0.7	7
Psychiatric illness	4	3.8	0.7	8.6
Others*	7	6.7	0	3.3
Previous hospitalization				
Yes	36	34.3	24.5	40
No	69	65.7	60	75.5
Primary admission diagnosis				
Head injury	24	22.9	14.3	32.0
Polytrauma	8	7.6	1.9	13.3
Tetanus	7	6.7	1.9	11.7
ARDS	7	6.7	2.6	12.4
Status epileptics	7	6.7	1.9	11.4
Disseminated tuberculosis	6	5.7	1.6	9.8
Guillain–Barre syndrome	6	5.7	1.9	9.8
Renal failure	6	5.7	1.6	10.8
Stroke	6	5.7	1.9	10.5
Poisoning	5	4.8	0.7	9.8
Bronchial asthma	4	3.8	0.7	7.6
Brain tumor	3	2.9	0.0	7.0
Others**	16	15.2	8.3	21.3

*: HIV, peptic ulcer disease, diabetes mellitus, cardiac illness, hypertension, chronic kidney disease. **: Pyogenic meningitis, congestive heart failure, pre-eclampsia/eclampsia syndromes, thyroid storm, fat embolism syndrome, *Pneumocystis jirovecii* pneumonia, post-revived cardiac arrest, Myasthenic crisis, acute liver failure. ACSH: Ayder Comprehensive Specialized Hospital, ICU: Intensive care unit, ARDS: Acute respiratory distress syndrome

Indication, the process of care, and outcome of MV

The most common indications for invasive MV were acute hypoxic respiratory failure (44.8%) followed by patients with GCS<8, that is, comatose patients (35.2%). The leading causes of acute hypoxemic respiratory failure were aspiration pneumonia, acute respiratory distress syndrome, and pulmonary edema (cardiogenic and non-cardiogenic). More than half (58.1%) received sedative drugs and nearly half took either thiopental or diazepam. In addition, around two-thirds (69.5%) were on analgesic medication.

More than two-third (67.6%) of the patients were on MV for <10 days. In addition, 11.4% of them stayed under invasive MV for more than 21 days.

Most patients who received invasive MV were in the ICU for <24 h before intubation. Most patients stayed <10 days under MV. In patients under invasive MV, successful weaning and extubation were achieved in 64 patients accounting for 61% [Table 3].

MV-related complications were seen among 67 (63.8%) of the patients. The leading complications were as follows: Upper gastrointestinal bleeding, VAP, and acute kidney injury (AKI) accounting for 30 (28.6%), 29 (27.6%), and 24 (22.9%), respectively. Nearly one-third (28.6%) died [Table 3].

Determinants of MV-related mortality

Predictors of MV-related mortality are presented in [Table 4]. After adjusting for confounding variables, advanced age

Table 3: Indication, the process of care, and outcome variables of invasive mechanical ventilation among patients admitted to ACSH ICU from January to November 2017.

Variable	Frequency	Percent	95% confidence interval	
			Lower	Upper
Indication for invasive MV				
Hypoxic respiratory failure	47	44.8	25.8	67
Glasgow Coma Scale < 8	37	35.2	28.6	45.1
Single breath count < 12 (respiratory depression)	6	5.7	1	10.5
Requirement for high-dose sedative agents	6	5.7	1.6	10.5
Comatose survivors of cardiac arrest and post CPR	5	4.8	1	10.5
Acute post-procedural respiratory failure – ICD 10 J95.82	4	3.8	0	7.6
Days patient stayed in ICU before invasive MV				
≤1.00	94	89.5	83.8	97.1
2.00–3.00	6	5.7	1.0	11.1
4.00–5.00	3	2.9	0.0	6.7
8.00+	2	1.9	0.0	5.1
Duration of mechanical ventilation in days		Median (IQR)=8 (5,14) days		
<10	71	67.6	59.7	78.4
10–20	22	21.0	14.4	27.6
>20	12	11.4	4.8	18.1
ICU length of stay in days		Median (IQR)=10 (7,18) days		
≤10.00	54	51.4	42.6	63.2
11.00–20.00	32	30.5	20.1	40.0
21.00–30.00	10	9.5	2.9	15.8
31.00+	9	8.6	3.2	15.2
Events during mechanical ventilation				
Successful weaning and extubation	64	61.0	53.0	69.8
Died while the patient was on MV	30	28.6	20.0	40.0
Accidental extubation and reintubation	8	7.6	2.9	13.3
The patient's next of kin requested extubation against medical advice	3	2.9	0.0	6.0
Sedation given				
Yes	61	58.1	48.3	66.0
No	44	41.9	34.0	51.7
Analgesia given				
Yes	73	69.5	59.0	75.5
No	32	30.5	24.5	41.0
Venous thromboembolism prophylaxis given				
Yes	77	73.3	64.5	82.5
No	28	26.7	17.5	35.5
Gastric ulcer prophylaxis given				
Yes	102	97.1	94.3	99.0
No	3	2.9	1.0	5.7
Complications after invasive MV				
Yes	67	63.8	54.9	72.4
No	38	36.2	27.6	45.1
Types of complications/adverse outcomes after invasive MV				
Ventilator-associated pneumonia				
Yes	29	27.6	17.8	37.1
No	76	72.4	62.9	82.2
Stress-related upper gastrointestinal bleeding				
Yes	30	28.6	21.0	37.4
No	75	71.4	62.6	79.0
Acute kidney injury				
Yes	24	22.9	15.9	29.5
No	81	77.1	70.5	84.1

(Contd...)

Table 3: *(Continued).*

Variable	Frequency	Percent	95% confidence interval	
			Lower	Upper
Septic shock				
Yes	21	20.0	10.5	28.5
No	84	80.0	71.5	89.5
Liver failure				
Yes	9	8.6	3.8	14.3
No	96	91.4	85.7	96.2
Catheter-associated urinary tract infection				
Yes	5	4.8	1.6	9.8
No	100	95.2	90.2	98.4
Bedsores				
Yes	3	2.9	0.0	6.7
No	102	97.1	93.3	100.0
Venous thromboembolic event				
Yes	1	1.0	0.0	3.2
No	104	99.0	96.8	100.0
Pneumothorax				
Yes	5	4.8	0.7	8.6
No	100	95.2	91.4	99.3
Endotracheal tube blockage				
Yes	6	5.7	1.9	10.8
No	99	94.3	89.2	98.1
Tracheostomy use				
Yes	34	32.4	23.5	44.8
No	71	67.6	55.2	76.5
Patient outcome				
Improved	75	71.4	62.0	80.9
Died	30	28.6	19.1	38.0

ACSH: Ayder Comprehensive Specialized Hospital, ICU: Intensive care unit, MV: Mechanical ventilation, CPR: Cardiopulmonary resuscitation, ICD: International classifications of disease

Table 4: Determinants of MV-related mortality in ACSH adult ICU, from January 1, 2017, to October 20, 2017.

Variables	*n*=105(%)	AOR, 95%	*P*-value
Age 60+years	17 (16.2)	2.68 (1.90, 7.94)	0.04*
Duration of illness > 7 days	24 (23)	1.72 (0.55, 5.31)	0.345
GCS 6–8	27 (25.7)	0.187 (0.028, 1.261)	0.085
GCS 9–13	21 (20)	0.299 (0.042, 2.120)	0.227
GCS 14+	36 (34.3)	0.149 (0.019, 1.115)	0.068
MV-related complication	67 (63.8)	1.32 (0.37, 4.72)	0.664
Septic shock	21 (20)	7.42 (2.10, 26.18)	0.002*
AKI	24 (22.9)	1.25 (0.36, 4.31)	0.720
Liver failure	9 (8.6)	2.10 (0.36, 12.18)	0.406

*Shows statistically significant with $P<0.05$. ACSH: Ayder Comprehensive Specialized Hospital, ICU: Intensive care unit, GCS: Glasgow Coma Scale, MV: Mechanical ventilation, AKI: Acute kidney injury

(age > 60 years) conferred a 2-fold increase in the odds of death (adjusted odds ratio [AOR] 2.6; 95% CI 1.9–7.9), while septic shock was associated with a 7-fold increase odds of death (AOR 7; 95% CI: 2.1–26.1). Among the complications developed after intubation and invasive MV, septic shock was statistically associated with MV-related mortality. Patients who developed septic shock as a complication after invasive MV were 7 times more likely to die compared to their counter groups (AOR of 7.4 with 95 % C.I: 2.1, 26.1) [Table 4].

DISCUSSION

This study revealed that 36.7% of the patients who were admitted to the critical care unit at ACSH during the study period received invasive MV. This was comparable to invasive MV usages in Egypt and India which showed rates of 34.5% and 31.5%, respectively.[8,15] This was also consistent with the rate of 33% in a multinational study involving the United States, Canada, Europe, and Latin America conducted by Esteban *et al*.[7] However, invasive MV use was lower than in a previous study in a similar setting in Ethiopia, which showed a rate of 47.7%.[9] The increased rate might be associated with the fact that the latter ICU was only for surgical patients which mandates liberal use of MV for

many surgical patients including post-thoracic surgeries as prophylaxis for 24 h.

The leading indications for invasive MV in this study were hypoxic respiratory failure, 47 (44.8%) and coma, 37 (35.2%), the indications of which are similar to other studies elsewhere.[2,8] Another study conducted elsewhere in Ethiopia showed respiratory failure as a leading indication for MV.[17]

The median (IQR) duration of MV, which was 8 (5, 14) days, is relatively longer than the findings of published multinational studies.[7] However, this was similar to a study conducted among critically ill patients in low-resource settings in India.[18] The median (IQR) ICU length of stay was 10 (7,18) days, which is longer than the multinational study done by Esteban *et al*.[7] where the median was 7 days. This difference might be related to multiple factors. First, lack of uniformity related to the weaning protocols physicians employ. Second, this is an open ICU setting where all credentialed physicians at ACSH can admit to the ICU. Third, patients get the intubation by the trained internist or anesthesia on duty whoever is available at the admission time and direct laryngoscopy is the method used for intubation. Fourth, there is no ICU protocol developed for analgosedation and physicians use the available medications based on their experience. Fifth, there is no respiratory physiotherapist, and hence, chest physiotherapy is performed by the ICU nurses and physicians themselves. These aforementioned factors are a plausible explanation for the longer duration of MV in the study setting. Tracheostomy was performed in 34 (32.4%) of the patients starting as early as day 1 and as late as day 25 of invasive MV. The median (IQR) duration of MV for tracheostomized patients was 15.5 (11–28). The high number of tracheostomy use is likely because of the need for prolonged intubation in patients with head injury and polytrauma which accounted for about 30% of the patients in this ICU.

The requirement for prolonged MV in this hospital was 11.4% which was consistent with a published report which showed an average of 10% (varying from 4% to 13%) of all mechanically ventilated patients.[19] Age above 60 years was significantly associated with MV-related mortality which is congruent to the published study from a low-resource setting and high-income countries which have found that age has an independent effect on the outcome of patients treated with MV after ICU admission.[7,20-23] Although chronological age is not a barrier to intensive care treatment and MV,[24] older age is a predictor of poor survival most probably related to the limited physiological reserves of people of this age group. Moreover, the incidence of acute respiratory failure increases markedly with age and is especially high among persons >65 years of age and contributes to one-third of hospital mortality.[25]

This study revealed the reintubation rate to be 8.5% in extubated patients. The rate of unplanned extubation was 16% which is almost comparable to a study from another similar setting which reported a rate of 20%.[19] A multinational study in 2002 by Esteban *et al*. also reported that 12.2% required reintubation in the first 48 h.[7]

The MV-related complications including AKI, liver failure, and pneumothorax were comparable to the multinational study done by Esteban *et al*. in 2002.[7] However, the VAP rate which was 27.6% in this study was higher than the above-mentioned multinational study which showed a VAP development of 9.8%. This is likely due to the absence of VAP infection prevention protocols in our setup.

VAP, followed by catheter-associated urinary tract infection (CAUTI), was the leading source of infection among the patients who were under invasive MV; patients who developed septic shock had a significant risk of death. This is in line with the study by Esteban *et al*. where septic shock was associated with a significant risk of death.[7] Similarly, a prospective study of medically ill patients in another low-resource setting showed septic shock as an independent factor associated with a high risk of mortality related to invasive MV.[19] In addition, a study from high-income settings showed that older age and sepsis are independent predictors of hospital death among patients admitted to medical ICU.[26] Employing cost-effective and evidence-based interventions as part of a "Ventilator bundle" including elevation of the patient's head of the bed to 30–45° and daily oral care (with a toothbrush) are known to reduce the incidence of VAP in ICU.[27-29] In addition, implementing targeted strategies for preventing CAUTI such as limiting the use and duration of urinary catheters, using an aseptic technique for catheter insertion, and adhering to proper catheter care should be endorsed in ICU to lower the incidence of sepsis and septic shock after intubation.[30]

In the present study, patients who received invasive MV for more than 12 h had 28.6% mortality rate. This rate is lower than a study in South Ethiopia which revealed a mortality of 46.8%.[11] A study of unselected patients in critically ill patients who required invasive MV in another low-resource setting showed a mortality rate of 37%.[19] In limited resource settings, the mortality rate of invasive MV usage is higher and ranges from 36% to 72%.[31-33]

The mortality rate in this study is close to the global trends.[7] The mortality rate in this study is lower than in low-income and some middle-income countries. A study in India revealed a 71.5% mortality rate in mechanically ventilated patients.[34] The lower mortality among the mechanically ventilated patients in our setting might be attributed to low associated morbidities similar to a study by Feng *et al*. Advanced patient age was significantly associated with high mortality in patients who received invasive MV.[35]

Limitations of the study

The main limitation of this study was that the duration of the follow-up period was not adequate as it did not address the post-ICU discharge mortality and long-term mortality. It also did not put into consideration how the mechanical ventilator parameters were set.

CONCLUSION

MV was one of the main reasons patients get admitted to the ICU. A third of patients admitted to ICU required invasive MV. Hypoxic respiratory failure and coma were the two most common indications for invasive MV. The mortality rate among patients under MV in this study was comparatively lower than in most resource-limited settings. Age above 60 years and septic shock development after intubation were independent determinants for MV-related mortality. The finding of this study may help in the decision-making process regarding MV for older people and the need for standard MV protocols including adherence to a "ventilator bundle" to prevent complications after intubation.

DECLARATIONS

Ethical approval and consent to participate

Ethical clearance was obtained from the Health Research Ethical Review Committee of Mekelle University (ERC0933/2017), College of Health Science Institutional Review Board (IRB). Before data collection, an authorization letter was secured from the medical director's office. Patient identifiers such as names were not collected, and care was taken to keep patient confidentiality.

Availability of data and materials

The dataset generated and analyzed during this study is available and can be shared with the corresponding author upon reasonable request.

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Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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ANNEX 1: DATA COLLECTION TOOL

Data collection tool for clinical characteristics and determinants of invasive mechanical ventilation outcome in adult intensive care unit in North Ethiopia

The research aims to assess the indication and outcome of patients who were on invasive mechanical ventilation after being admitted to Ayder Comprehensive Specialized Hospital adult ICU. The information contained does not mention names of the patients under study and it will be kept confidential.

Part 1: Questions assessing sociodemographic characteristics of patient

1. Age of the patient…….
2. Sex a. Male b. Female
3. Residence a. Urban b. Rural
4. Educational status
   a. Higher education
   b. Secondary school
   c. Primary school
   d. No formal education
5. Admission date of the patient…….
6. Hospital MRN of the patient…….

Part 2: Questions assessing clinical characteristics of the patient

1. What is the admission primary diagnosis?
2. What is the measurement of the following vital and clinical signs at admission?
   a) Blood pressure (SBP/DBP)……
   b) Temperature……
   c) Pulse rate…….
   d) Respiratory rate……
   e) Oxygen saturation by pulse oximeter……..
   f) Urine output in the first 24 h of admission……
   g) Glasgow Coma Scale……
3. Any comorbid illness apart from the primary admission diagnosis
4. Previous hospitalization related to the current illness……..
5. Duration of the illness before ICU admission……

Part 3: Questions assessing the laboratory and radiologic findings of the patient

1. What is the chest radiologic finding of the patient?
2. What are the measurements of the following laboratory investigations?
   a. Hemoglobin…….
   b. Serum creatinine…….
   c. Serum potassium……
   d. Serum albumin…….
3. HIV status of the patient? A. Positive B . Negative C. Unknown

If positive, recent CD4 count……

Part 4: Questions assessing factors related to invasive mechanical ventilation

1. What are the date of intubation or tracheostomy insertion and mechanical ventilation?
2. What is the indication for mechanical ventilation?
   a. Hypoxic respiratory failure: Desaturation with SpO_2 < 90% on face mask oxygen for >30 min and or tachypnea of >35/min for more than 30 min
   b. Post-CPR
   c. GCS < 8 (air way protection)
   d. Post-immediate anesthesia/post-procedure
   e. Single breath count < 12
   f. Requirement for high-dose sedation
   g. Mention if other_____
3. Is sedation used in this patient? a. Yes b. No If yes what is/are the drug/s……
4. Is analgesia used in this patient? a. Yes b. No If yes what is/are the drug/s……
5. Did the patient receive any form of VTE prophylaxis? a. Yes b. No
6. If yes to question number 5, what was the drug given?_____
7. Did the patient receive any form of GI ulcer prophylaxis? a. Yes b. No
8. If yes to question number 7, what was the drug used?_____
9. Is there any noticed or detected complication after mechanical ventilation of the patient?
   a. Yes
   b. No
10. If yes for Q.9: What was the new complication detected after invasive MV?
    a. Catheter-associated UTI
    b. VAP
    c. AKI: Type of the AKI - (i) Pre-renal AKI (ii) Intrinsic AKI (iii) Post-renal
    d. UGIB – stress ulcer related
    e. Septic shock
       (i) Focus of the sepsis
    f. Liver failure
    g. Bedsore
    h. Venous thromboembolism(DVT/VTE)
    i. Barotrauma (pneumothorax)
    j. ETT/tracheostomy blockage
11. What was the date of the above complication detected?
12. Total number of days patient stayed on mechanical ventilation?
13. Was tracheostomy done to the patient? a. Yes b. No
14. If yes for question 13: On which day after intubation was the tracheostomy done?

15. What is the course event of mechanical ventilation during ICU stay?
    a. Successfully planned extubation
    b. Planned extubation but with subsequent reintubation
    c. Accidental extubation and reintubation done
    d. Accidental extubation but no reintubation done
    e. Self-extubation with subsequent MV required
    f. Self-extubation but no subsequent MV required
16. What is the duration of ICU stay in days?
17. What is the outcome of invasive mechanical ventilation?
    a. Successfully weaned from ventilator support
    b. Died while patient is on MV or in ICU stay
18. If the patient died, the date and time shift of death….
19. What was the possible immediate cause of death?
    a. Refractory septic shock
    b. ETT or tracheostomy blockage
    c. Cardiorespiratory arrest of the primary underlying diagnosis
    d. Sudden death, unexplained
    e. Increased ICP
    f. Multiorgan failure
    g. Mention if other